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Modeling and short circuit detection of 18650 Li-ion cells under mechanical abuse conditions

by

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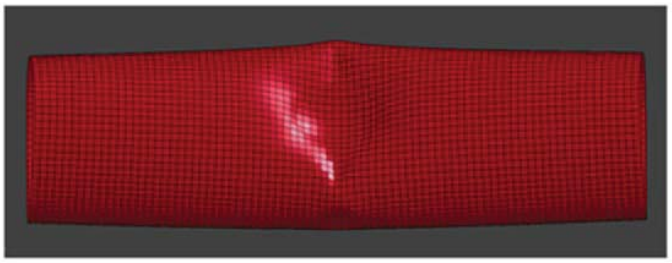

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Abstract

In this research a simple, yet accurate model of a single cell, needed for safety assessment of batteries under mechanical abuse conditions, was developed. Extensive testing was performed on a 18650 lithium ion cell, including indentation by a hemispherical punch, lateral indentation by a cylindrical rod, compression between two flat plates, and three-point bending. The batteries were tested in an environmental chamber at a 10% SOC. A finite element model was developed, composed of shell elements representing outside casing, and solid elements for the active material with a binder lumped together with the current collectors and the separator. The jelly roll is modeled as a homogenized and isotropic material. The homogenous model assumes different properties in tension and compression, but does not account for the effect of structural anisotropy caused by the layered nature of the jelly roll. Very good correlation was obtained between LS Dyna numerical simulation and test results in terms of load displacement relations, deformed shape of the battery, and initiation and propagation of a crack in the shell casing. The FE model was also capable of predicting the onset of short circuit of the cell

Keywords: Short-circuit, Mechanical abuse, Cylindrical cell, Finite element modeling